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For: DIGITAL SUBSCRIBER LINE COMMUNICATING SYSTEM AND A TRANSCEIVER IN THE SYSTEM

TRANSLATOR'S DECLARATION

Honorable Commissioner of Patents & Trademarks
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Sir:

I, Toshiaki Terasaki , residing at c/o A. AOKI, ISHIDA & ASSOCIATES, Toranomon 37 Mori Bldg., 3-5-1, Toranomon Minato-ku, Tokyo 105-8423, Japan declare the following:

(1) That I know well both the Japanese and English languages;

(2) That I translated Japanese Patent Application No. 10-172464 , filed June 19, 1998 , from the Japanese language to the English language;

(3) That the attached English translation is a true and correct translation of the aforesaid Japanese Patent Application No. 10-172464 to the best of my knowledge and belief; and

(4) That all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereon.

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Date

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[TITLE OF THE INVENTION] Digital Subscriber Line Transmission System

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[Title of the Invention] Digital Subscriber Line Transmission System

[Scope of Claim for Patent]

[Claim 1] A digital subscriber line transmission system using a telephone line as a transmission line, comprising training means:

wherein the training means performs an initialization according to a single bitmap when channel analysis, except for a transceiver training, exchange, a C-MEDLEY and R-MEDREY, is effected; and when the channel analysis is effected by the C-MEDREY and the R-MEDREY only, the training means checks the line quality by both the inside symbol and the outside symbol in a dual bitmap, and the training means checks the line quality by the inside symbol only in a single bitmap.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a digital subscriber line transmission system which utilize an existing telephone line as a high speed data communication line. More particularly, it relates to an improvement of a modulation/demodulation system in a transmission apparatus used in the above-mentioned transmission system.

In recent years, multimedia services such as internet and so forth have expanded through society and into homes. Accompanied by such development, it has been strongly required to promptly provide an economical and reliable digital subscriber line transmitting system for utilizing such services.

[0002]

[Prior Art]

(1) An explanation of an ADSL

As a technique to provide a subscriber line communicating system which utilizes an existing telephone line

as a high speed data communication line, an xDSL (Digital Subscriber Line) is known. xDSL is a communicating system which utilizes a telephone line and a modulation/demodulation technique. xDSLs are generally classified into a symmetric type and an asymmetric type. In the symmetric type, upstream transmission speed from a subscriber home (hereinafter referred to as a subscriber side) to an accommodating office (hereinafter referred to as a central office side) is symmetric with the transmission speed from the central office side to the subscriber side. In the asymmetric type, the transmission speed from the subscriber side to the central office side is asymmetric with the transmission speed from the central office side to the subscriber side.

[0003]

In the asymmetric xDSLs, there is an Asymmetric DSL (ADSL) which is provided with the G.DMT standard having a downstream transmission speed of about 6 Mbit/sec. and the G.lite standard having a downstream transmission speed of about 1.5 bits/sec. Both of the G.DMT and G.lite employ Descrete Multitone (DMT) modulation.

(2) An Explanation of the DMT Modulation

DMT modulation will be explained with reference to Fig. 11 using G.lite as an example. This explanation and the associated drawing will describe only the downstream modulation/demodulation from the central office to the remote terminal.

[0004]

Firstly, transmitting data is input into an apparatus and a one-symbol time (1/4 kHz) of the data is stored in a serial to parallel buffer. The stored data are divided into a plurality of groups. A predetermined number of transmission bits per carrier signal is previously allocated to each group in accordance with a transmitting bitmap 60 (which will be described later in detail). Each group is output to an encoder. In the encoder 20, each group of the input bit series is converted into a signal point for an

orthogonal amplitude modulation and is output to IFFT 30. The IFFT 30 performs the orthogonal amplitude modulation for each of the signal points to perform an inverse fast Fourier transform. The signals from the IFFT are output to a parallel to serial buffer 40. Here the sixteen points of the outputs 240-255 of the IFFT are added as a Cyclic Prefix to the head of each DMT symbol. The output of the parallel to serial buffer 40 is supplied to a D/A converter 50 in which the digital signal with a sampling frequency of 1.104 MHz is converted into an analog signal. The analog signal is transmitted through a metalic line 100 to a subscriber side.
[0005]

At the subscriber side, the analog signal is converted into a digital signal of 1.104 MHz by an A/D converter 110. Each DMT symbol of the digital signal is stored in a serial to parallel buffer 120. In the buffer, the Cyclic Prefix is removed from the digital signal, and the remaining signal is output to an FFT 130. In the FFT 130, a fast Fourier transform is effected to generate (demodulate) the signal points. The demodulated signal points are decoded by a decoder 140 in accordance with a receiving bitmap 160 having the same values as those in the transmitting bitmap 60. The decoded data are stored in a parallel to serial buffer 150 as receiving data of bit-sequences.

(3) A Detailed Explanation of the Bitmap

The bitmap described in the explanation of the DMT modulation will be explained in detail with reference to Fig. 12.
[0006]

The apparatus at the central office side and the apparatus at the subscriber side both measure the ratio of the line signal to noise (hereinafter referred to as S/N) during a training period for communication to determine the number of bits to be transmitted by each modulating carrier. As shown in Fig. 12, for a carrier signal with a larger S/N, a larger number of bits to be transmitted are allocated; and for a

carrier signal with a smaller S/N, a smaller number of bits to be transmitted are allocated.

[0007]

By the above, the receiving side measures the S/N to prepare the bitmap which indicates the numbers of bits to be transmitted corresponding to the carrier numbers.

The receiving side informs this bitmap to the transmitting side during a training period so that both the transmitting side and the receiving side can perform the modulation/demodulation with the use of the same bitmap during normal data communication.

(4) Countermeasure Against Cross-Talk From the ISDN Ping-Pong Transmission

When there is a cross-talk due to the ISDN Ping-Pong Transmission (hereinafter referred to as TCM Cross-Talk), the previously described two bitmaps were used in the ADSL so as to improve the transmission characteristic. This method of using the two bitmaps will be explained with reference to Fig. 13.

[0008]

In the ISDN Ping-Pong transmission, the central office side transmits downstream data during a prior half of the 400 Hz shown in Fig. 13, in synchronization with the 400 Hz; and the subscriber side receives the downstream data and then transmits upstream data. Therefore, the ADSL modem in the central office is influenced by a Near End Cross-Talk (hereinafter referred to as NEXT) from the ISDN during the prior half of the one cycle of 400 Hz, and is influenced by a Far End Cross-Talk (hereinafter referred to as FEXT) from the subscriber side ISDN during the latter half of one cycle of 400 Hz.

[0009]

Contrary to the central office, the ADSL in the subscriber side is influenced by a FEXT during a prior half of one cycle of the reference clock signal of 400 Hz, and is influenced by a NEXT during a latter half of the cycle.

If the metalic cable between the central office and the subscriber is long, the S/N of the receiving signal to the NEXT is made smaller, and in some cases, the NEXT may be greater than the receiving signal.

[0010]

In these cases, as the influence of the FEXT is not so large, in the prior art, two bitmaps were provided. One was a bitmap (DMT symbol A) for receiving signals during the NEXT period. The other was a bitmap (DMT symbol B) for receiving signals during the FEXT period. During the NEXT period, the number of bits to be transmitted was made small so as to improve the resistance of the signals against the S/N. During the FEXT period, the number of bits to be transmitted was made large so as to increase the transmission capacity.

[0011]

On the other hand, the time interval of one DMT symbol is usually 246 μs with a Cyclic Prefix of 16 points. Contrary to this, in the prior art, in order to synchronize the DMT symbols with the TCM Cross-talk period of 400 Hz, the time interval of one DMT symbol is made to be 250 μs with a Cyclic Prefix of 20 points so that one period of the TCM Cross-talk is made to synchronize with the time period of ten DMT symbols.

(5) FEXT and NEXT

Fig. 1 is a timing chart showing the cross-talk that the ADSL receives from the TCM-ISDN.

[0012]

The TCM-ISDN is operated out at a frequency of 400 Hz with the period of 2.5 ms. During the first half cycle of each period of the TCM-ISDN, the CO side transmits symbols and during the latter half cycle of the period, the RT side transmits symbols. In the first half cycle of the period of TCM-ISDN, therefore, the center ADSL unit (ATU-C) is affected by the near end cross-talk (NEXT) from the TCM-ISDN, and in the latter half cycle, the ATU-C is affected by the far end cross-talk (FEXT) from the TCM-ISDN. On the other hand, the

subscriber ADSL unit (ATU-R) is affected by the FEXT from the TCM-ISDN during the first half cycle of the one TCM-ISDN period, and by the NEXT from the TCM-ISDN during the latter half cycle thereof. In this specification, the time areas affected by NEXT and FEXT in this way will be called the NEXT duration and the FEXT duration, respectively.

[0013]

The center ADSL unit (ATU-C) in the central office side can estimate the FEXT duration and the NEXT duration at the subscriber ADSL unit (ATU-R) in the RT side. Also, the ADSL unit (ATU-R) in the subscriber side can estimate the FEXT duration and the NEXT duration at the center ADSL unit (ATU-C) in the central office side. That is, each period is defined as follows.

FEXT: FEXT duration at ATU-R estimated by ATU-C

NEXT: NEXT duration at ATU-R estimated by ATU-C

FEXT: FEXT duration at ATU-C estimated by ATU-R

NEXT: NEXT duration at ATU-C estimated by ATU-R

The transmission delay is also taken into consideration in these definitions.

(6) Sliding Window

For the purpose of providing a digital subscriber line transmission system capable of transmitting the ADSL signal in satisfactory manner in the cross-talk environment from the TCM-ISDN described above, the present applicant has earlier proposed to introduce a "sliding window" in Japanese Patent Application No. 10-144913.

[0014]

According to the above-mentioned Patent Application No. 10-144913, in the downstream transmission of the ADSL signal from the center ADSL unit (ATU-C) to the subscriber ADSL unit (ATU-R), the state of the ADSL signal transmitted by the center ADSL unit (ATU-C) in the cross-talk environment from the TCM-ISDN is defined as follows.

That is, in the case where the transmission symbol is completely contained in the FEXTR duration, as shown in

Fig. 2, the center ADSL unit (ATU-C) transmits the symbol as an inside symbol by means of the sliding window. Also, in the case where the transmission symbol is included in the NEXTR duration even partially, the center ADSL unit (ATU-C) transmits the symbol as an outside symbol.

[0015]

Also, the center ADSL unit (ATU-C) transmits the inside symbol using a bitmap A for the FEXTR duration and the outside symbol using a bitmap B for the NEXTR duration (Dual Bitmap).

Similar to in the downstream transmission, the subscriber ADSL unit (ATU-R) transmits the inside symbol using the bitmap A for the FEXTC duration and transmits the outside symbol using the bitmap B for the NEXTC duration in the upstream transmission.

[0016]

Here, there is a case where the center ADSL unit (ATU-C) does not use the bitmap B (Single Bitmap). In such a case, the center ADSL unit (ATU-C) transmits only the pilot tone outside of the sliding window. In similar fashion, there is case where the subscriber ADSL unit (ATU-R) does not use the bitmap B, in which the subscriber ADSL unit (ATU-R) transmits nothing outside of the sliding window.

[0017]

[Problems to be Solved by the Invention]

As described above, an effective ADSL transmission technique, under a noisey environment, from the TCM-ISDN has been proposed, for example, in Japanese Patent Application No. 10-144913 by the present applicant. Nevertheless, a specific training method for the ADSL transceiver in employing such a transmission technique or means for carrying out the training method have yet to be studied.

[0018]

The present invention has been developed based on new knowledge and study of the points described above, and the object thereof is to provide a digital subscriber line

transmission system and a communication apparatus used for the transmission system accompanied by a specific training method for the ADSL transceiver in employing an effective transmission technique for the ADSL signal under a noisey environment from the TCM-ISDN or including means for carrying out such a training method.

[0019]

[Means to Solve the Problems]

According to a first aspect of the present invention, there is provided a digital subscriber line transmission system having a telephone line as a transmission line, comprising training means, the training means performing an initialization according to a single bitmap during a transceiver training and exchange, and channel analysis except for a C-MEDLEY and R-MEDREY; and when the channel analysis is effected by the C-MEDREY and the R-MEDREY only, the training means checking the line quality by both the inside symbol and the outside symbol in a dual bitmap; and the training means checking the line quality by the inside symbol only in a single bitmap.

[0020]

On the other hand, according to a second aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising a center ADSL unit (ATU-C) and a subscriber ADSL unit (ATU-R) respectively having independent counters, and a hyper-frame counter (501) for continuously counting a predetermined number of times (for example, 345 times) of DMT symbol clocks (510) to count the number of DMT symbols.

[0021]

Further, according to a third aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising, in the above-mentioned second construction, means (523) for determining a FXTR, NEXTR, FEXTC, or NEXTC in a sliding window by means of a sliding window DEC (503) by using a counter value of a

counter.

Still further, according to a fourth aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising means (507) for making a 400 Hz signal (517) as a sequence transition condition in the center ADSL unit (ATU-C) at the start of a C-REVEILLE and C-RATES1, and in the subscriber ADSL unit (ATU-R) in order to coincide the start of a R-REBERB3 with the phase of 400 Hz, and means for clearing a hyper-frame counter (501) at that time.

[0022]

Still further, according to a fifth aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising a symbol number counter (505) for counting the number of symbols by counting DMT symbol clocks (519), and means for determining the length of each initialization signal by making the coincidence of the count value with the value of a count value DEC (513) as a sequence transition condition (507).

[0023]

Still further, according to a sixth aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising means for making transition information (521) such as a detecting signal received from an external source or a CRC calculated result to be a transition condition logic (507), to make an enable signal of a sequence counter (511), whereby the count value of the sequence counter (511) becomes a code value representing the state of an initializing sequence, and initialization information (525) for determining initialization signal (C=REVEILLE, C-PILOT1, C-REVERB1, etc) to be transmitted is prepared by an initialization DEC using the count value of the sequence counter (511).

[0024]

Still further, according to a seventh aspect of the present invention, there is provided a digital subscriber line

transmission system characterized by comprising, different from the above-mentioned first construction, means for effecting a training only in a FEXT period when the initialization is effected according to a dual bitmap.

Still further, according to an eighth aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising means for effecting a training continuously regardless of whether it is the FEXT period or the NEXT period by making the coefficient updating step size to be 0 or very small value in the NEXT period in a TEQ and FEQ training.

[0025]

Still further, according to a ninth aspect of the present invention, there is provided a digital subscriber line transmission system characterized by comprising means for using an inverse synchronization symbol (I) together with a synchronization symbol (S), said inverse synchronization symbol (I) being in each hyper frame.

[0026]

Still further, according to a tenth aspect of the present invention, there is provided a digital subscriber line transmission system comprising means wherein, in the above-mentioned ninth aspect, when the inverse synchronization symbol (I) is received at the receiving side, the phase of each carrier except for a pilot tone after the FET (130) shown in Fig. 12 is rotated by 180°, whereby the state becomes the same as the time when the synchronization symbol (S) is received, and after that, the training is carried out by using the synchronization symbol generated at the receiving side.

[0027]

Still further, according to an eleventh aspect of the present invention, there is provided a digital subscriber line transmission system comprising means wherein, in the above-mentioned ninth aspect, in a phase detection for a frame synchronization, when the phase detection is carried out by using a synchronization symbol (S), acknowledgement is carried

out in the next inverse synchronization symbol (I), and when the phase detection is carried out by using the inverse synchronization symbol (I), acknowledgement is carried out in the next synchronization symbol (S).

[0028]

According to a twelfth aspect of the present invention, there is provided a digital subscriber line transmission system comprising means wherein, at the subscriber side ADSL unit (ATU-R), after receiving a 74-th carrier transmitted from the center side ADSL unit (ATU-C), the FET (130) shown in Fig. 12 is effected so that a FEXTR period or a NEXTR period is recognized by the output phase of the FET, and by using the information, the phase of 400 [Hz] which is a burst synchronization of the TCM-ISDN is recognized.

[0029]

According to a thirteenth aspect of the present invention, there is provided a digital subscriber line transmission system comprising means wherein, different from the above-mentioned twelfth aspect of the present invention, in the subscriber side ADSL unit (ATU-R), after receiving a 74-th carrier transmitted from the center side ADSL unit (ATU-C), QPSK demodulation is carried out as shown in Fig. 5, and as a result, the FEXTR period or the NEXTR period is recognized, and by using the information, the phase of the TCM-ISDN 400 [Hz] is recognized.

[0030]

According to a fourteenth aspect of the present invention, there is provided a digital subscriber line transmission system comprising means wherein, in the center side ADSL unit (ATU-C) as shown in Fig. 7, in order to recognize the 400 [Hz] within the unit, when the TCM-ISDN 400 [Hz] is input from an external source, the TCM-ISDN 400 [Hz] is not input to an oscillator (VCXO) (704) within the center side ADSL unit (ATU-C) so as to establish a synchronization with the APLL (703), but an NTR 8 [kHz] from an external source (the TCM-ISDN 400 [Hz] and NTR 8 [kHz] are synchronized

in frequency) is input to the VCXO so as to establish a synchronization with the oscillating frequency (704) of the center side ADSL unit (ATU-C) and to generate 400 [Hz] by dividing it.

[0031]

[Mode for Carrying Out the Invention]

An embodiment of the present invention will be described below with reference to the drawings.

(1) Initialization

Fig. 3 schematically shows timing charts for the initialization of the ADSL transceivers. At the time of ADSL training, it is important to send out ADSL signals only during the period when the NEXT noise for the TCM-ISDN is not generated at the TCM-ISDN receiving side, taking the effect on the TCM-ISDN into account for both upstream and downstream transmission. For this reason, as shown in Fig. 3, during the transceiver training and exchange sequence, the initialization is performed according to the single bitmap mode. Also, during the channel analysis sequence, the initialization is performed according to the single bitmap mode for the sequences other than the C-MEDLEY and the R-MEDLEY. During the C-MEDLEY and the R-MEDLEY only, on the other hand, the line quality is checked, that is, S/N is measured by both the inside and outside symbols according to a dual bitmap mode, or by the inside symbol only according to a single bitmap mode.

(2) Initialization Counter

Fig. 4 shows an embodiment of an initialization counter according to the present invention.

[0032]

In an ADSL, the center ADSL unit (ATU-C) and the subscriber ADSL unit have respective independent counters. The hyperframe counter (501) counts the number of DMT symbols by counting the DMT symbol clocks (519) a predetermined number of times (for example, 345 times) continuously. Using this count value, the sliding window DEC (503) discriminates whether a transmitting or receiving DMT symbol belongs to a

FEXTR, NEXTR, FEXTC or NEXTC duration in the sliding window. [0033]

Also, the center ADSL unit (ATU-C) starts the C-REVEILLE and C-RATES1, and the subscriber ADSL unit ATU-R starts the R-REVERB3, respectively, synchronized in phase with the timing signal (517) having a frequency of 400 Hz. This can be realized by making the 400 Hz timing signal (517) as the condition for sequence transfer in the transition condition logic unit (507) and by clearing the hyperframe counter (501) in response to the timing signal. The symbol number counter (505) counts the number of DMT symbols by counting the DMT symbol clocks (519), and the fact of coincidence with the number of the DMT symbols output from the count decoder (513) is made as a condition for sequence transfer in the transition condition logic unit (507), the length of each initialization signal is determined. Also, the sequence transition information (521) such as a receiving signal detecting signal from the external or a CRC calculating result is made as a transition condition logic (507) to generate an enable signal of the sequence counter (511). Thus, count value of the sequence counter (511) is a code value representing the state of the initialization sequence. By using the count value of the sequence counter (511), the initialization decoder (515) generates an initialization information (525) determining the initialization signals (the C-REVEILLE, C-PILOT1, C-REVERB1, etc.) to be transmitted. [0034]

The above-described configuration has been described as realized with hardware, however, it can also be realized in software with a similar configuration.

Also, in the C-PILOT1, the phase of the TCM-ISDN of 400 Hz is notified from the center ADSL unit (ATU-C) to the subscriber ADSL unit (ATU-R), which in turn detects and converts it into a signal of 400 Hz. In this method, though described in detail later, the subscriber ADSL unit (ATU-R) can periodically detect cross-talk of TCM-ISDN or the like.

(3) Transceiver Training

The transceiver training includes training sequences of a TEQ, an FEQ, an AGC, a timing recovery, and a frame synchronization. These trainings are performed when a pseudo random signal such as a synchronization symbol (S) is repeatedly sent out by the ADSL transceiver. In the transceiver training sequence, the initialization is performed according to a single bitmap mode in which the training is performed only in the FEXT duration as a matter of course.
[0035]

It should be noted that there may be a case in which, in the transceiver training sequence, initialization is carried out according to a dual bitmap mode or the training is carried out only in the FEXT duration.

In the TEQ and FEQ training, continuous training is possible regardless of the FEXT duration or the NEXT duration. In this case, the step size for updating coefficients of the TEQ and FEQ in the NEXT duration is made to be zero or to be a very small value.

(4) Inverse synchronization symbol

As shown in Figs. 8 and 9, each hyperframe contains one inverse synchronization symbol (I). In each training, however, the inverse synchronization symbol (I) is also used in combination with the synchronization symbol (S) in the following manner in order to improve the synchronization rate.
[0036]

Upon receipt of the inverse synchronization symbol (I) at the receiving side, the phase of each carrier except for the pilot tone is rotated by 180 degrees after the FET (130) shown in Fig. 1B. As a result, the same state is realized as when the synchronization symbol (S) is received. Then, the training is carried out using the synchronization symbol (S) generated at the receiving side.

For detecting a phase for the frame synchronization, in the case where the synchronization symbol (S) is used to detect the phase, the detection is checked with the next

inverse synchronization symbol (I), and in the case where the inverse synchronization symbol (I) is used to detect the phase, on the other hand, the detection is checked with the next synchronization symbol (S).

(5) Method of Informing the Phase of TCM-ISDN Timing Signal With 400 Hz From Center ADSL Unit (ATU-C) to Subscriber ADSL unit (ATU-R)

A method for informing the phase of TCM-ISDN timing signal with 400 Hz from the center ADSL unit (ATU-C) to the subscriber ADSL unit (ATU-R) is described in detail below.

[0037]

In addition to the pilot tone, the C-PILOT1 transmits a 74th carrier (319.125 kHz) belonging to the frequency band with small cross-talk from TCM-ISDN. The phase of TCM-ISDN timing signal with 400 Hz is informed from the center ADSL unit (ATU-C) to the subscriber ADSL unit (ATU-R) in the 74-th carrier using 2 bits in the manner described below. This informing process is shown in Fig. 10.

[0038]

[Table 1]

SUBJECT TO BE INFORMED	BIT SEQUENCE BEFORE MODULATION	PHASE AFTER MODULATION
$FEXT_R$ DURATION (BITMAP A)	{0, 0}	(++)
$NEXT_R$ DURATION (BITMAP B)	{0, 1)	(+-)

The subscriber ADSL unit (ATU-R) receives the 74-th carrier sent thereto from the center ADSL unit (ATU-C) and recognizes the phase of the TCM-ISDN with 400 Hz by either of the two methods described below.

(1) Method of Recognizing the Phase of the TCM-ISDN With 400 Hz by Performing a FFT

The subscriber ADSL unit (ATU-R), after receiving the 74-th carrier, executes the FFT (130) shown in Fig. 12B. From the phase of this FFT output, it recognizes whether the carrier belongs to the FEXTR duration or the NEXTR duration. The subscriber ADSL unit recognizes the phase of

the TCM-ISDN timing signal of 400 Hz using this information.
[0039]

In this method, however, the subscriber ADSL unit (ATU-R) can recognize the phase of the TCM-ISDN 400 Hz only with a relatively low accuracy. The following method is effective for achieving a higher accuracy.

(2) Method of Recognizing the Phase of the TCM-ISDN With 400 Hz by Carrying Out QPSK Demodulation

The subscriber ADSL unit (ATU-R) executes the QPSK demodulation as shown in Fig. 5 after receiving the 74-th carrier. From this result, it recognizes that the receiving signal belongs to the FEXTR duration or the NEXTR duration. Using this information, it recognizes the phase of the TCM-ISDN with 400 Hz.
[0040]

This method makes it possible for the subscriber ADSL unit (ATU-R) to recognize the phase of the TCM-ISDN with 400 Hz with a high accuracy.

(6) Method of Configuring PLL of TCM-ISDN 400 Hz Burst Clock

Fig. 6 shows a reference model of the ATU-C transmitter. As shown in Fig. 6, the center ADSL unit (ATU-C) is kept supplied with a signal of 8 kHz clock called NTR (network timing reference) from an external source. The signal of the TCM-ISDN with 400 Hz may also be supplied from an external source. The TCM-ISDN with 400 Hz may alternatively be generated in the center ADSL unit (ATU-C) without being supplied from an external source (see Japanese Patent Application No. 10-115223, for example). In this process, the TCM-ISDN with 400 Hz and the 8 kHz NTR are synchronized in frequency with each other.
[0041]

In the center ADSL unit (ATU-C) shown in Fig. 7, when the TCM-ISDN with 400 [Hz] (702) is input from an external source in order to recognize the 400 [Hz] (702) within the unit, synchronization is not established in the PLL

(703) by inputting the TCM-ISDN 400 [Hz] into an oscillator (VCXO) (704) within the center ADSL unit (ATU-C), but it is characterized in that synchronization is established with the oscillating frequency (704) of the center ADSL unit (ATU-C) by inputting an NTR 8 [kHz] (701) signal (the TCM-ISDN 400 [Hz] and the NTR 8 [kHz] are synchronized to each other) from an external source is input to the VCXO, and a signal with 400 [Hz] (709) is generated by dividing it.

[0042]

First, usually, the TCM-ISDN with 400 [Hz] (702) is input to the PLL within the center ADSL unit (ATU-C), and then the TCM-ISDN with 400 [Hz] is synchronized with the frequency of the internal VCXO (704). The oscillating frequency of the VCXO in the center ADSL unit (ATU-C) is generally about 17.664 [MHz]. In this case, when synchronizing with the TCM-ISDN 400 [Hz], a PLL synchronization operation is carried out by phase comparison information which is obtained one time for 44160 times (17.664 M/400).

Normally, the larger the number of phase comparisons, the smaller the phase jitter or the frequency error. The phase comparison conducted once for each 44160 times with the clock of 17.664 MHz, however, normally increases the phase jitter and the frequency error greatly.

[0043]

In order to avoid this, as the NTR (701) with 8 [kHz] synchronized with the TCM-ISDN of 400 [Hz] is always supplied to the center ADSL unit (ATU-C) from an external source, when this NTR with 8 [kHz] is used to perform the PLL synchronization operation of VCXO in the center ADSL unit (ATU-C), the number of times of the phase comparison increases to 20 times as much as for the TCM-ISDN timing signal with 400 [Hz]. Thus, the phase comparison information is obtained at the rate of once for each 2208 times, thereby making it possible to reduce the phase jitter and the frequency error.

[0044]

The embodiments of the invention described above

represent only an example, and other many modifications are conceivable. In any case, however, the present invention has, of course, the same effect.

[0045]

It will thus be understood from the foregoing detailed description that according to this invention, there are provided a specific training method for the ADSL transceiver in employing an effective transmission technique for the ADSL signal in the noise environment from the TCM-ISDN or a digital subscriber line transmission system and a communication apparatus comprising means for carrying out the particular training method.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1A is a block diagram showing a central office according to an embodiment of the present invention;

Fig. 1B is a block diagram showing a remote terminal according to an embodiment of the present invention;

[Fig. 1] is a timing chart of the TCM-ISDN cross-talk;

[Fig. 2] is a diagram showing a sliding window;

[Fig. 3] is a diagram schematically showing timing charts for initialization;

[Fig. 4] is a diagram of an initialization counter according to the invention;

[Fig. 5] is a diagram showing the QPSK demodulation;

[Fig. 6] is a diagram showing a reference model of the ATU-C transmitter;

[Fig. 7] is a diagram showing a timing reproducing algorithm in the ATU-C;

[Fig. 8] is a diagram showing a transmission pattern of SWB method at the central office side;

[Fig. 9] is a diagram showing a transmission pattern of SWB method at the subscriber side;

[Fig. 10] is a diagram showing a transmission pattern of each DMT symbol;

[Fig. 11] is a diagram showing the SWB method in the case where two bitmaps are used;

[Fig. 12] is a diagram showing the a functional blocks of a subscriber transmission system according to a DMT modulation method.

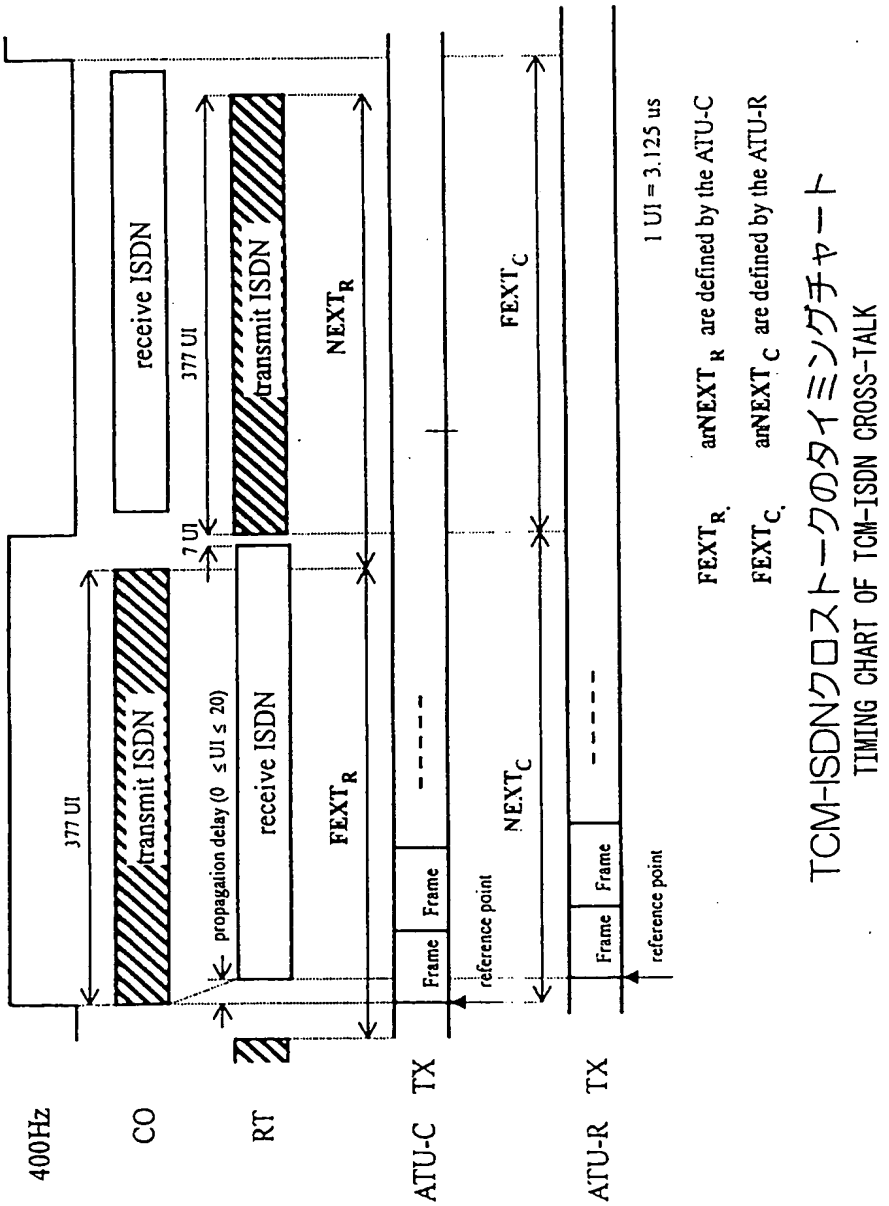
[Fig. 13] is a diagram showing the definition of a bitmap.

[Fig. 14] is a diagram showing a conventional example.

[Explanation of Symbols]

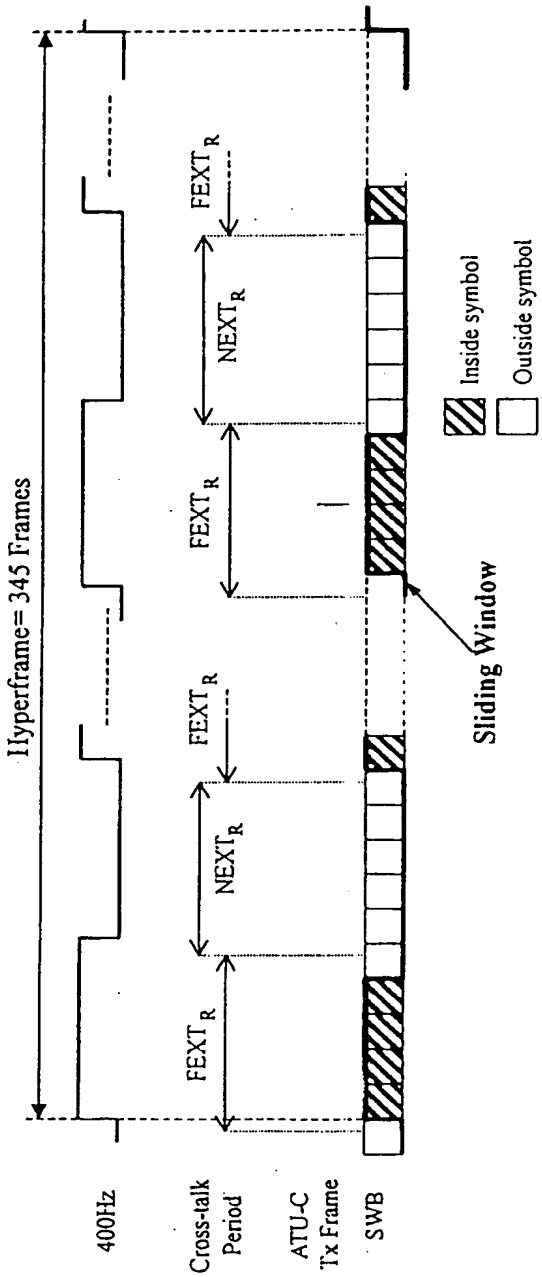
501 ... hyperframe counter
503 ... sliding window DEC
565 ... symbol number counter
507 ... transition condition logic
511 ... sequence counter
517 ... 400 Hz signal
519 ... DMT symbol clock
521 ... sequence transition information
525 ... initialization information

【書類名】　図面
[NAME OF DOCUMENT]　DRAWINGS
【図１】
[FIG. 1]



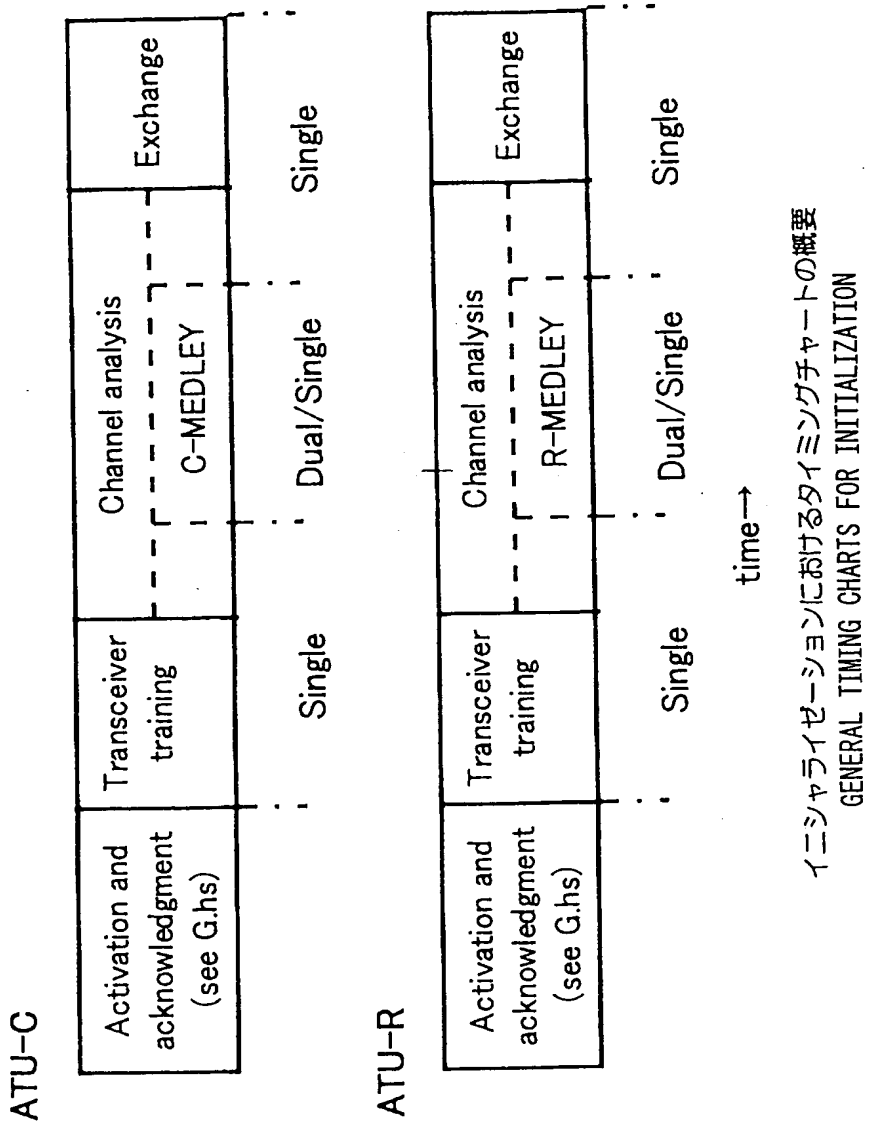
TCM-ISDNクロストークのタイミングチャート
TIMING CHART OF TCM-ISDN CROSS-TALK

【図２】
[FIG. 2]



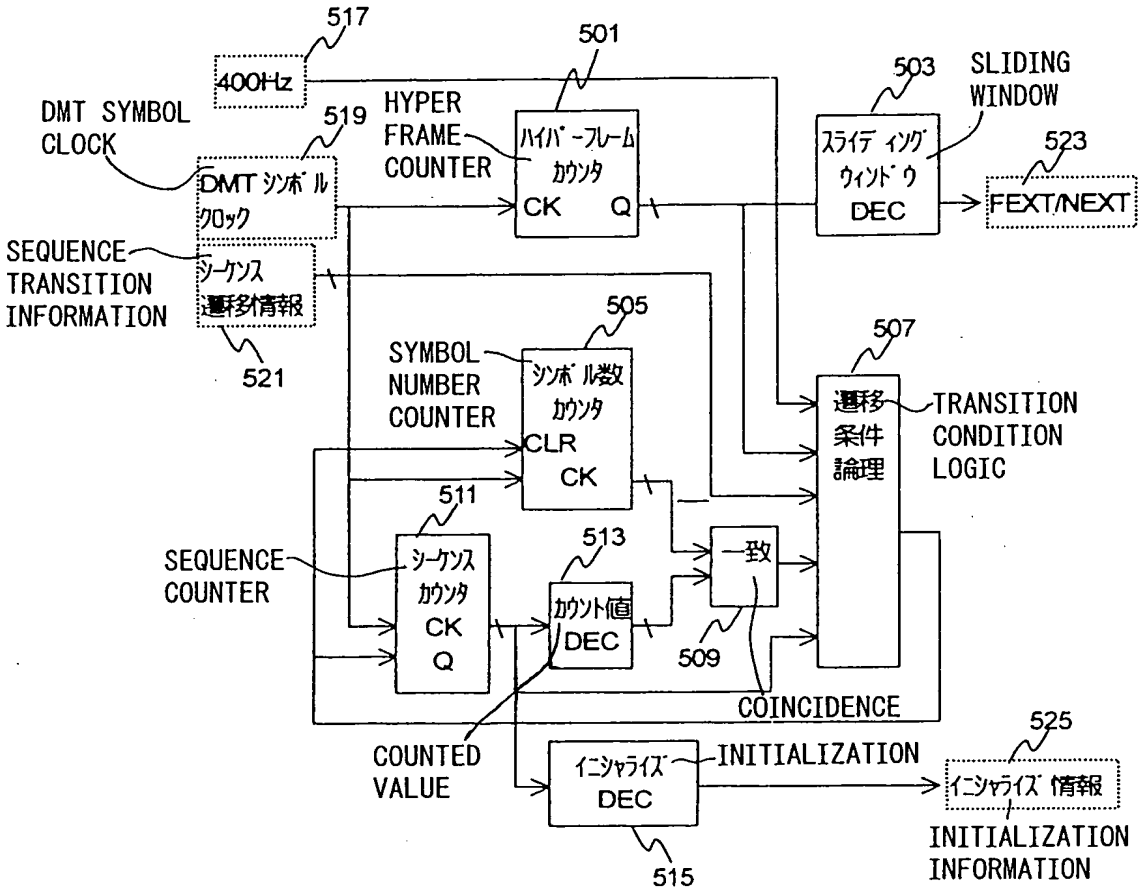
スライディング・ウインドウ
SLIDING WINDOW

【図３】
[FIG. 3]



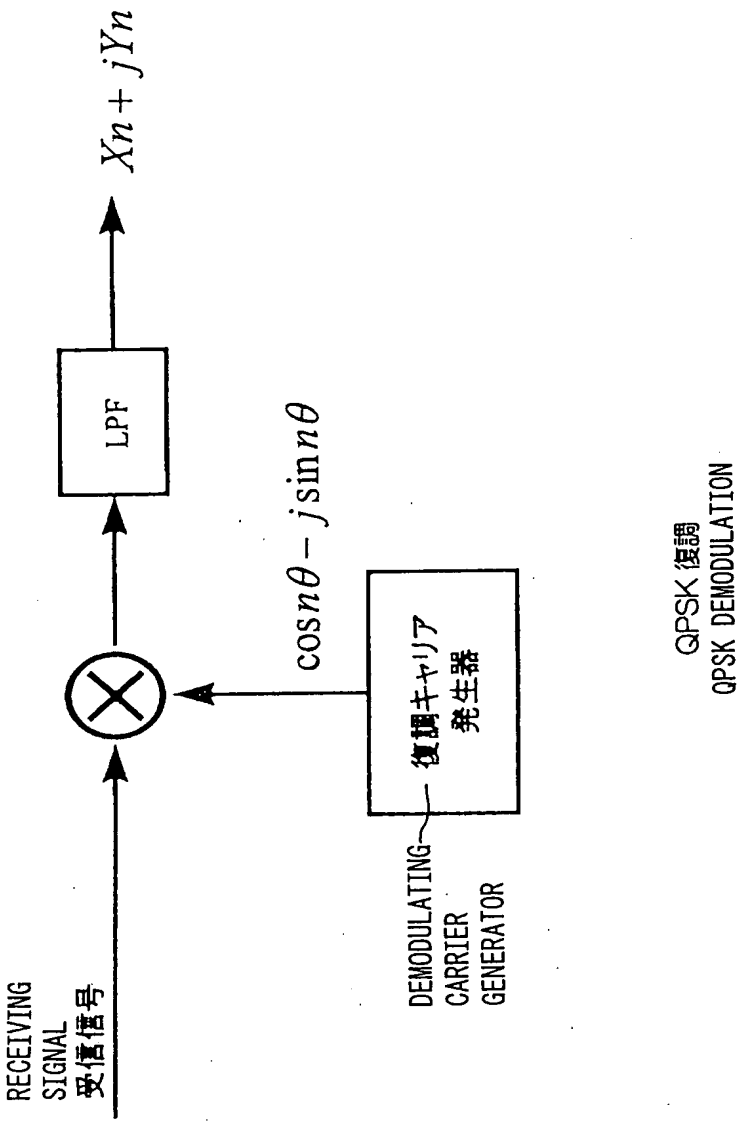
イニシャライゼーションにおけるタイミングチャートの概要
GENERAL TIMING CHARTS FOR INITIALIZATION

【図４】
[FIG. 4]

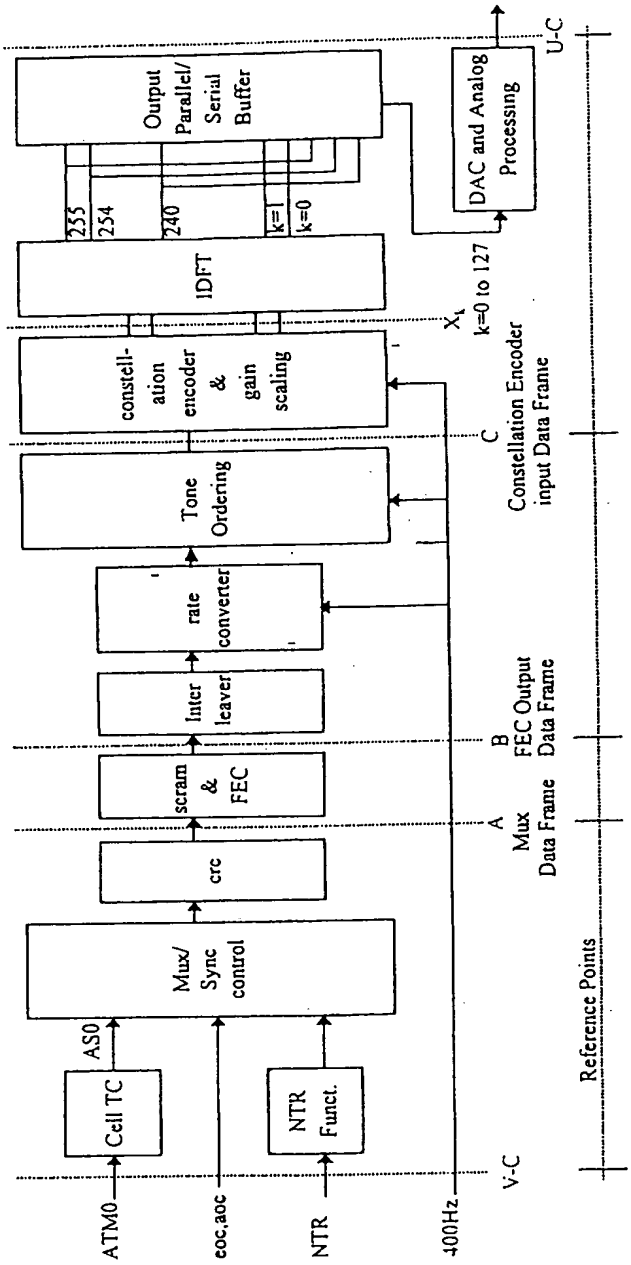


本発明のイニシャライズカウンタの実施態様
EMBODIMENT OF INITIALIZATION COUNTER OF THE PRESENT INVENTION

【図５】
[FIG. 5]

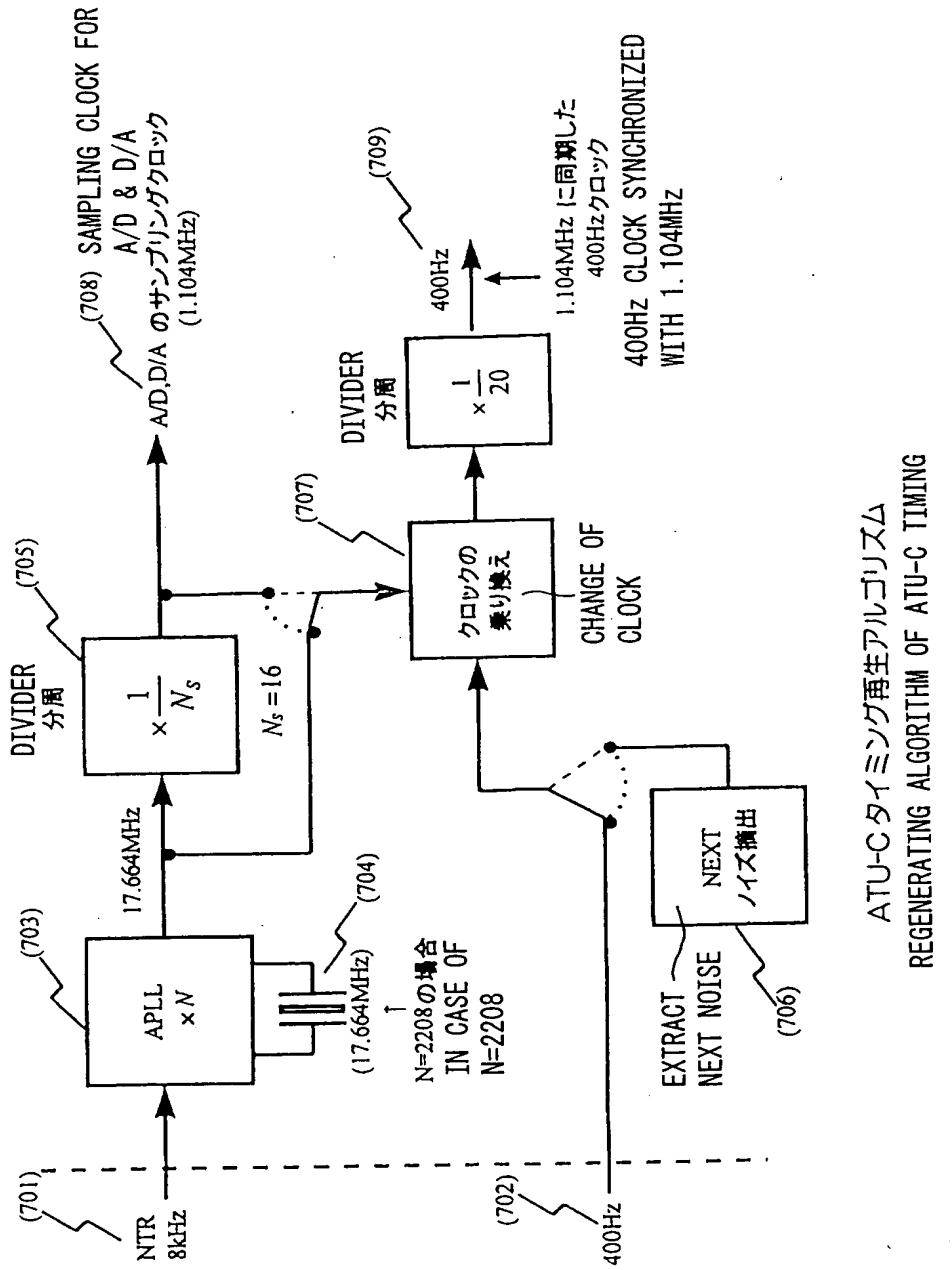

$Xn + jYn$
LPF
$\cos n\theta - j\sin n\theta$
復調キャリア
発生器
DEMODULATING
CARRIER
GENERATOR
RECEIVING
SIGNAL
受信信号
QPSK 復調
QPSK DEMODULATION

【図６】
[FIG. 6]



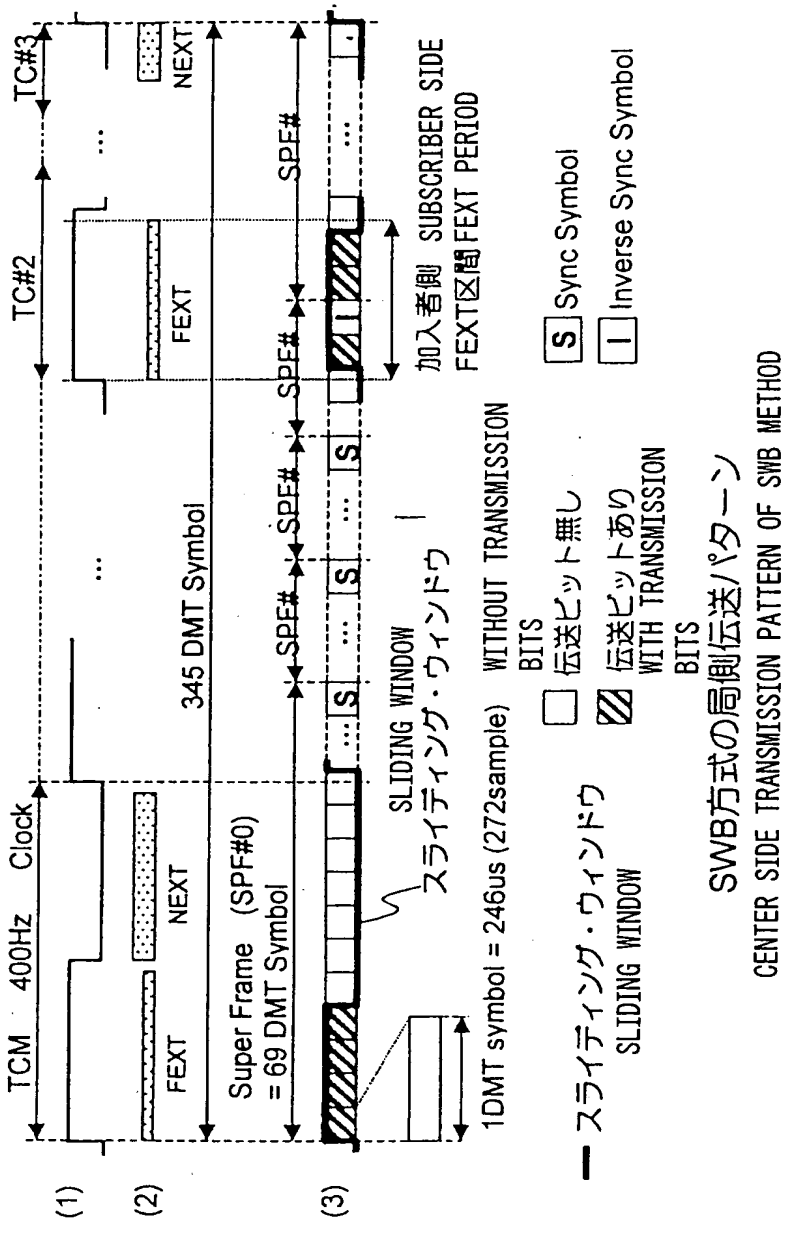
ATU-C送信器リファレンスモデル
REFERENCE MODEL OF ATU-C TRANSMITTER

【図７】
[FIG. 7]

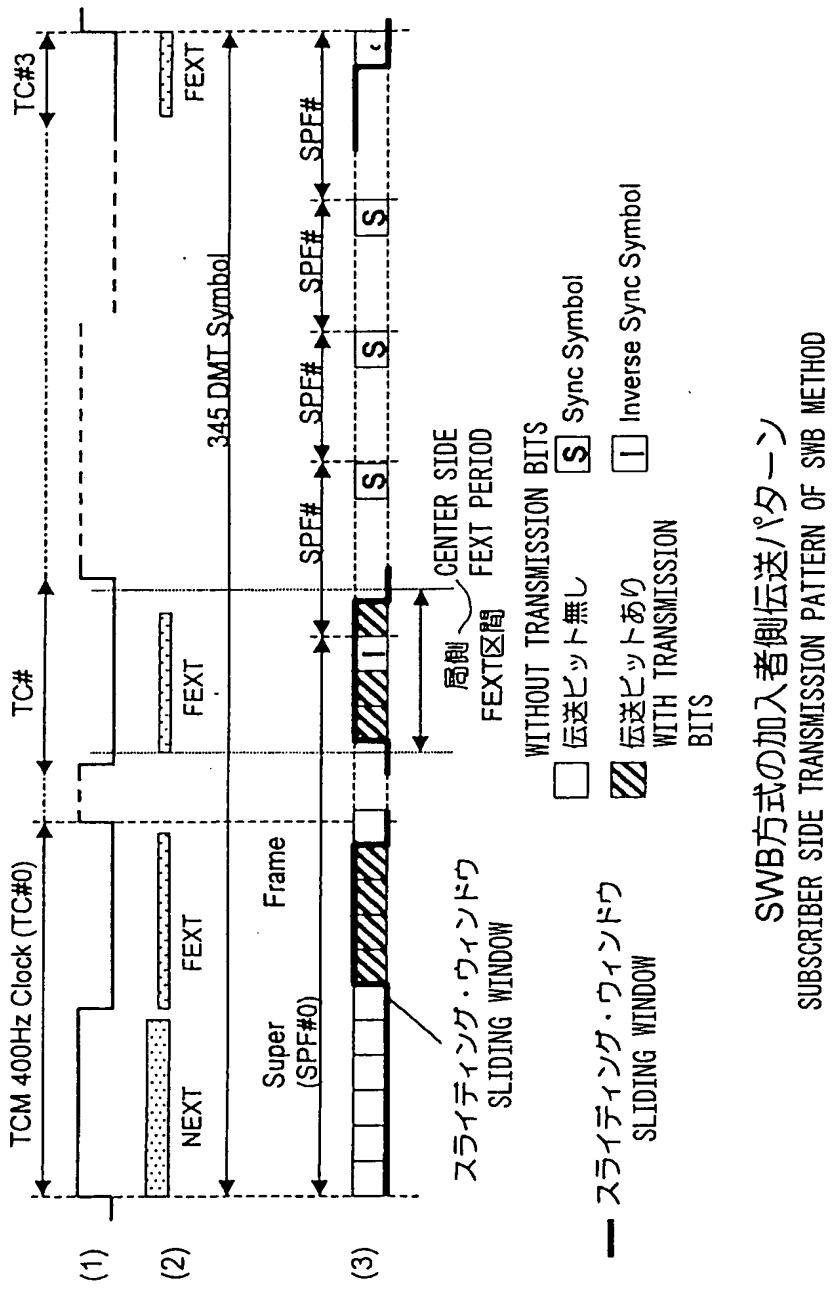


ATU-Cタイミング再生アルゴリズム
REGENERATING ALGORITHM OF ATU-C TIMING

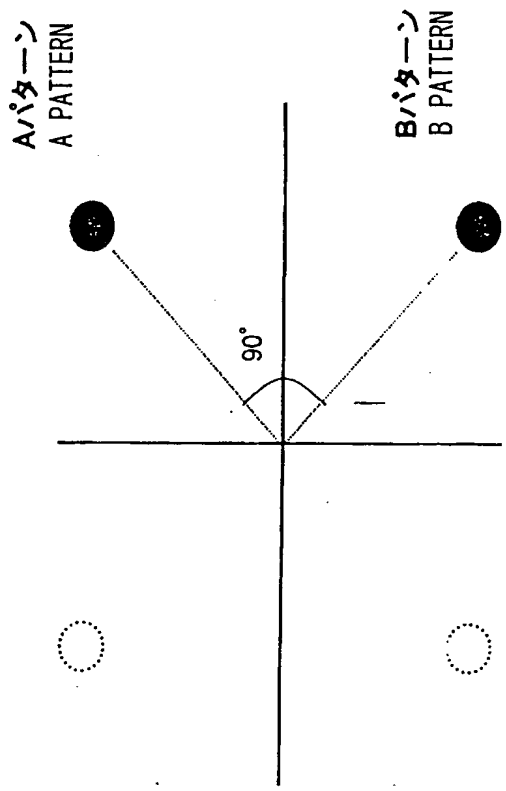
【図８】
[FIG. 8]


TCM
400Hz Clock
(1)
FEXT
NEXT
(2)
Super Frame (SPF#0)
= 69 DMT Symbol
345 DMT Symbol
TC#2
TC#3
SPF#
S
(3)
SLIDING WINDOW
スライディング・ウィンドウ
1DMT symbol = 246us (272sample)
WITHOUT TRANSMISSION BITS
伝送ビット無し
WITH TRANSMISSION BITS
伝送ビットあり
Sync Symbol
Inverse Sync Symbol
加入者側 SUBSCRIBER SIDE
FEXT区間 FEXT PERIOD
スライディング・ウィンドウ
SLIDING WINDOW
SWB方式の局側伝送パターン
CENTER SIDE TRANSMISSION PATTERN OF SWB METHOD

【図９】
[FIG. 9]

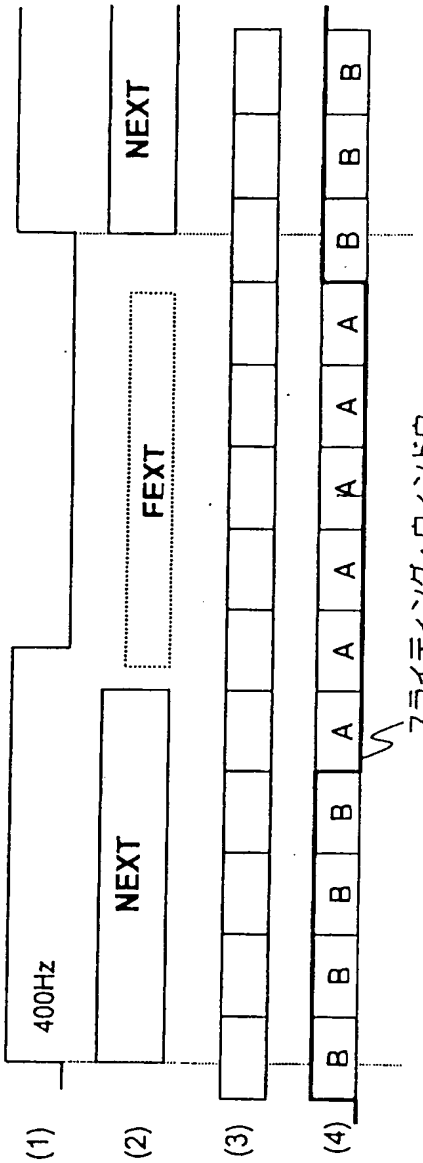

TCM 400Hz Clock (TC#0)
TC#
TC#3
NEXT
FEXT
FEXT
Super Frame
(SPF#0)
345 DMT Symbol
SPF#
SPF#
SPF#
SPF#
S
S
S
S
I
(1)
(2)
(3)
局側
CENTER SIDE
FEXT区間
FEXT PERIOD
スライディング・ウィンドウ
SLIDING WINDOW
WITHOUT TRANSMISSION BITS
伝送ビット無し
S Sync Symbol
伝送ビットあり
WITH TRANSMISSION BITS
I Inverse Sync Symbol
スライディング・ウィンドウ
SLIDING WINDOW
SWB方式の加入者側伝送パターン
SUBSCRIBER SIDE TRANSMISSION PATTERN OF SWB METHOD

【図１０】
[FIG. 10]



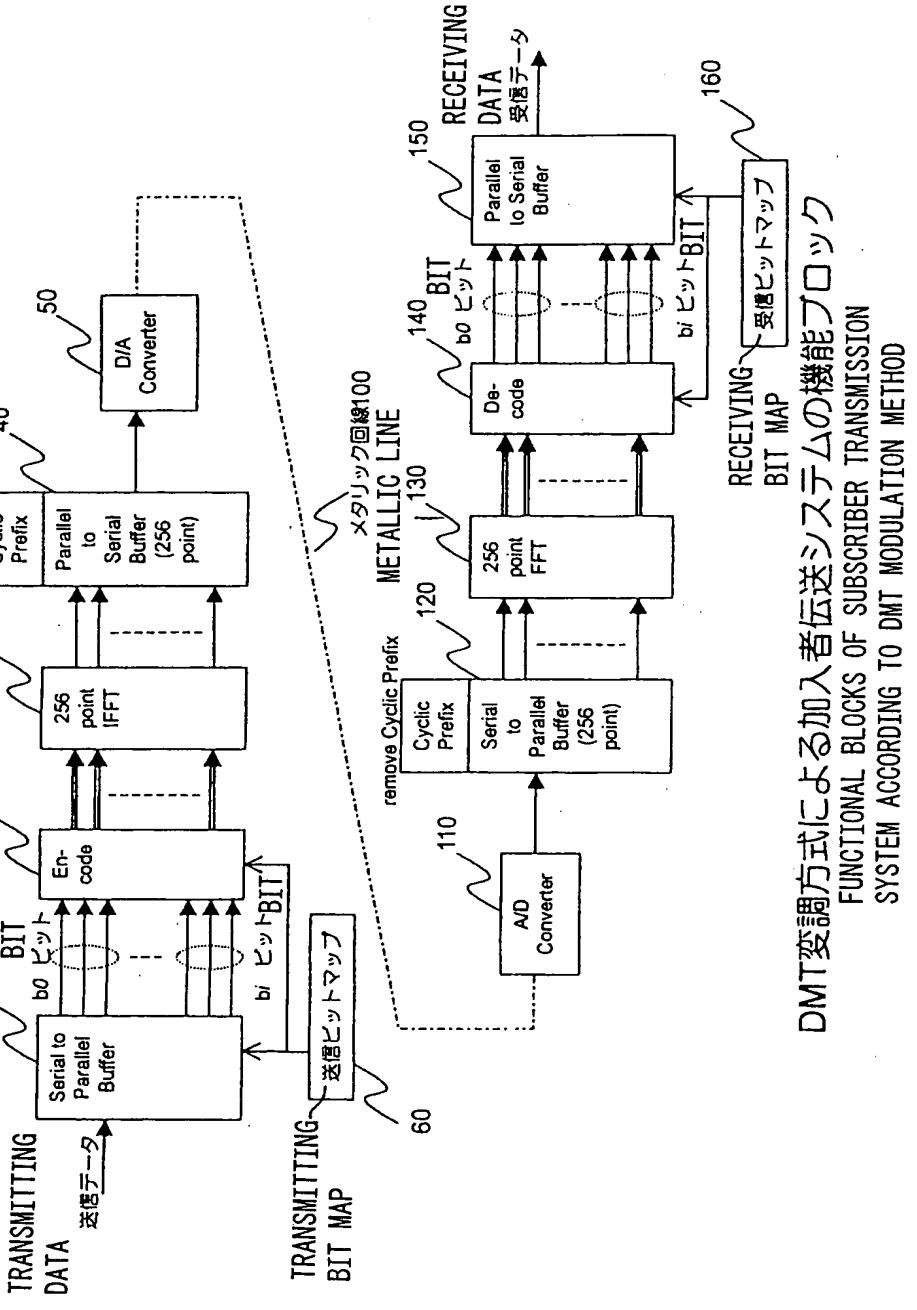
DMTシンボル毎の送信パターン
TRANSMISSION PATTERN OF EACH DMT SYMBOL

【図１１】
[FIG. 11]

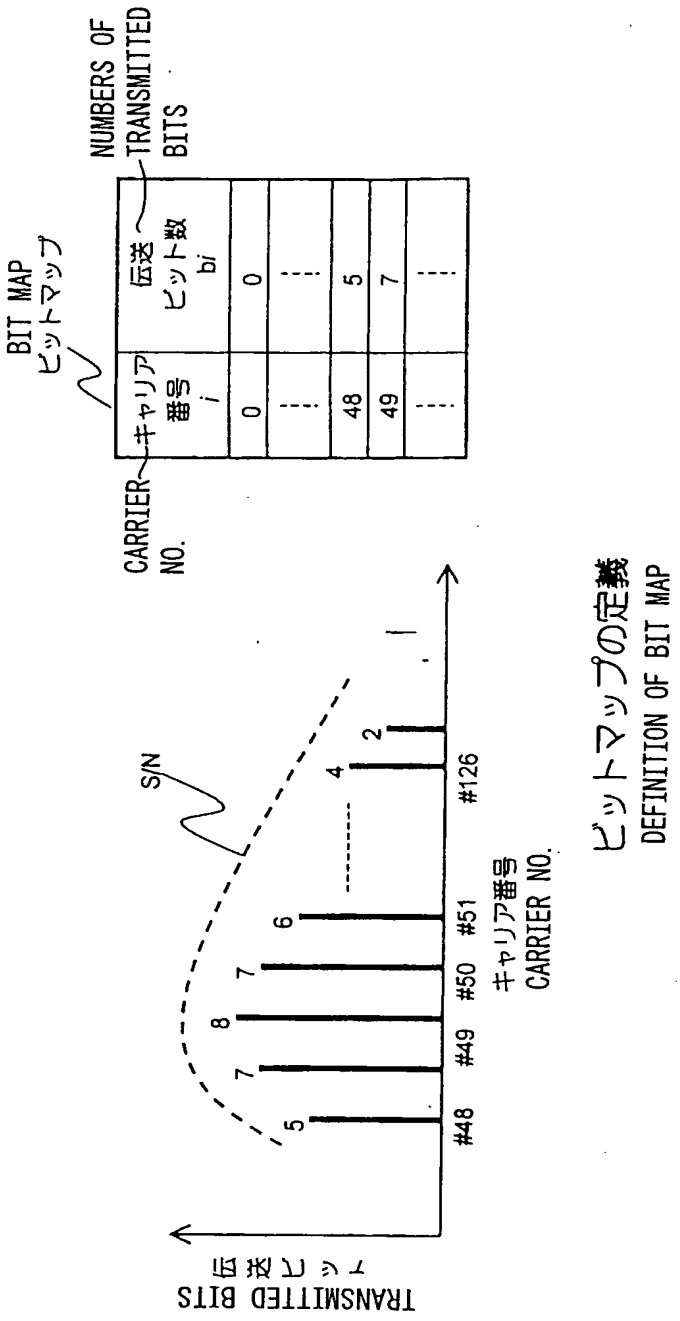


ビットマップを2個使用する場合のSWB方式
SWB METHOD WHEN TWO BIT MAPS ARE USED

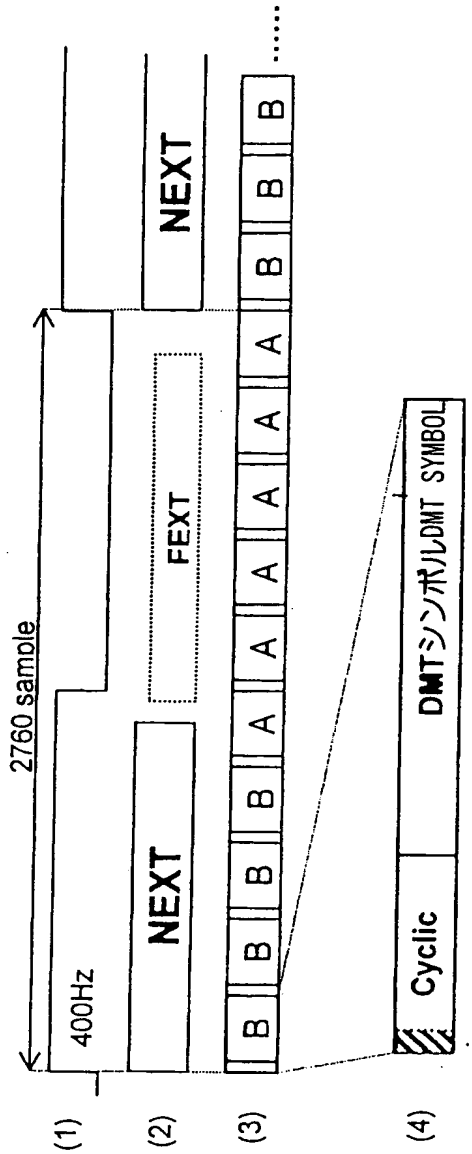
【図１２】
[FIG. 12]


TRANSMITTING DATA
送信データ
10
Serial to Parallel Buffer
BIT ビット
b0
bi
20
En-code
ビットBIT
30
256 point IFFT
40
Parallel to Serial Buffer (256 point)
Cyclic Prefix
50
D/A Converter
TRANSMITTING BIT MAP
送信ビットマップ
60
メタリック回線100
METALLIC LINE
110
A/D Converter
120
Serial to Parallel Buffer (256 point)
Cyclic Prefix
remove Cyclic Prefix
130
256 point FFT
140
De-code
150
Parallel to Serial Buffer
RECEIVING DATA
受信データ
160
RECEIVING BIT MAP
受信ビットマップ
DMT変調方式による加入者伝送システムの機能ブロック
FUNCTIONAL BLOCKS OF SUBSCRIBER TRANSMISSION SYSTEM ACCORDING TO DMT MODULATION METHOD

【図１３】
[FIG. 13]


BIT MAP
ビットマップ
NUMBERS OF TRANSMITTED BITS
伝送ビット数 bi
キャリア番号 i
CARRIER NO.
0
48
49
5
7
S/N
#48
#49
#50
#51
#126
キャリア番号
CARRIER NO.
TRANSMITTED BITS
ビットマップの定義
DEFINITION OF BIT MAP

【図１４】
[FIG. 14]



従来例
PRIOR ART EXAMPLE

[NAME OF DOCUMENT] ABSTRACT

[ABSTRACT]

[PROBLEMS] To provide a specific training method, or a digital subscriber line transmission system, and a communication unit used in it, comprising means for carrying out such a training method.

[Solving Means] In a digital subscriber line transmission system using a telephone line as a transmission line, training means is provided wherein an initialization is performed according to a single bitmap when channel analysis except for a transceiver training, exchange, a C-MEDREY and R-MEDREY; and when the channel analysis is effected by the C-MEDREY and the R-MEDREY only, the training means checks the line quality by both the inside symbol and the outside symbol in a dual bitmap, and the training means checks the line quality by the inside symbol only in a single bitmap.

[SELECTED DRAWING] Fig. 3